TITLE OF THE INVENTION

INSERTING PAPER FOR GLASS-LIKE SHEET MATERIALS

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BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to inserting paper to be inserted between glass-like sheet materials at the time of transport or storage of such glass-like sheet materials, more particularly relates to inserting paper reducing dirt on the glass surface by the inserting paper itself and suppressing generation of dust.

2. Description of the Related Art

Normally, at the time of transport or storage of sheet glass or other glass-like sheet materials, inserting paper is inserted between the glass-like sheet materials in order to improve handling. With the conventional inserting paper, in particular inserting paper made from recycled paper, at the time of transport and storage, the moisture on the surface of the glass (moisture in the air) reacts with the alkali ingredients of the glass to erode the glass and cause surface deterioration. Further, the ink contained in the recycled paper and the resin ingredients derived from the recycled paper material itself were transferred to the glass-like sheet materials to cause paper marks on the surface of the glass-like sheet materials.

To prevent the surface deterioration and paper marks seen at the time of use of conventional inserting paper, inserting paper with dispersed cut holes (for example, see Japanese Patent Publication (A) No. 5-208841), inserting paper in which zeolite is blended at the papermaking process (for example, see Japanese Patent Publication (A) No. 7-41034), inserting paper coated on its surface with a water soluble resin (for example, see Japanese Patent Publication (A) No. 9-170198), and inserting paper adjusted in hot water solubility (for example, see Japanese Patent Publication

(A) No. 2003-41498) have been developed. Improvements have been made to improve the hygroscopic property, the contact area of the surface, and other physical properties and these papers have been put into use.

With glass-like sheet materials used as the substrates for flat panel displays (FPD) such as liquid crystal displays (LCDs), plasma display panels (PDPs), and organic EL displays, however, a much higher surface cleanliness is now being demanded. However, even if utilizing the above types of inserting paper, it has been difficult to keep dirt at the glass surface down to the required level. Therefore, at the present time, these are not being used for the transport or storage of the "glass substrates" supplied to the display makers. They are only being used for "glass sheets" which are later coated with thin films to make the glass substrates.

Therefore, when transporting or storing glass substrates for display manufacturers, wide use is being made of the method of transport and storage while holding the glass-like sheet materials by plastic packaging spacers (for example, see Japanese Patent Publication (A) No. 2000-142873). With this method, it is possible to prevent the glass-like sheet materials from sticking to each other. It is also effective against dirt on the surface of the glass-like sheet materials. However, the packaging spacers mean wasted space between the glass-like sheet materials. There was therefore the problem that it was only possible to transport or store a small number of glass-like sheet materials at one time - resulting in higher costs of logistics and storage.

SUMMARY OF THE INVENTION

An object of the present invention is to provide inserting paper for clean glass-like sheet materials reducing transport and storage costs without relying on packaging spacers, preventing paper marks, and enabling electrostatic adhesion.

To attain the above object, there is provided inserting paper for glass-like sheet materials comprised of a nonwoven sheet made of cellulose, wherein a content of hot water solubles in the nonwoven sheet is less than 0.1 wt%. Since the paper is made of a nonwoven sheet made of cellulose, inclusion of ingredients other than cellulose such as seen in inserting paper made from conventional pulp or inserting paper coated with resin is eliminated. As a result, the content of the hot water solubles can be reduced to less than 0.1 wt%. This is extremely effective in suppressing dirt on the glass surface during transport or storage (paper marks).

Preferably, the nonwoven sheet is formed without using a binder. Since no binder is used in the formation of the nonwoven sheet, the inserting paper is formed from only cellulose (regenerated cellulose) and the transfer of impurities etc. contained to the glass surface such as seen in conventional inserting paper can be eliminated. As a result, it is possible to exhibit an even greater effect in suppressing dirt on the glass surface (paper marks), so transport and storage of glass-like sheet materials in an extremely clean state become possible.

More preferably, the nonwoven sheet is pressed by a flat roller. Since the nonwoven sheet is pressed by a flat roller, it becomes possible to suppress generation of dust when using the inserting paper made of the nonwoven sheet.

Still more preferably, the nonwoven sheet is supercalendered. Since the nonwoven sheet is supercalendered, it becomes possible to suppress generation of dust when using the inserting paper made of the nonwoven sheet. Since the smoothness of the surface of the nonwoven sheet is improved, the adhesion between the inserting paper (nonwoven sheet) and glass-like sheet materials utilizing static electricity is improved and the work of inserting the inserting paper between glass-like sheet materials is facilitated.

Still more preferably, a surface roughness of the nonwoven sheet is not more than 1.5 μm as measured by a KES-FB-4S surface tester. Since the surface roughness is less than 1.5 μm, it is possible to obtain good electrostatic adhesion with the glass-like sheet materials.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects and features of the present invention will become clearer from the following description of the preferred embodiments given with reference to the attached drawings, wherein:

FIG. 1 is a sectional view of a spun fiber according to an embodiment of the present invention;

FIG. 2 is a partially enlarged view of a nonwoven sheet according to an embodiment of the present invention; and

FIG. 3 is a schematic sectional view of an example of a suction system used for treatment for dust prevention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A preferred embodiment of the present invention will be described in detail below while referring to the attached figures.

The inserting paper for glass-like sheet materials of the present invention is a nonwoven sheet made from cellulose, in particular one in which the content of hot water solubles (hot water soluble ingredients) is suppressed to less than 0.1 wt% of the unit nonwoven sheet. Further, in the inserting paper for glass-like sheet materials of the present invention, the material made of the cellulose is formed into a nonwoven sheet without the use of a binder and the surface of the nonwoven sheet is suitably treated to prevent dust or supercalendered as explained in detail later.

The "cellulose" in the present invention is cellulose obtained from pulp prepared from cotton, wood chips, etc. by alkali dissolution etc. using the viscose process, cuprammonium process, or other known cellulose regenerating

process (so-called "regenerated cellulose"). This regenerated cellulose includes fiber-shaped rayon (viscose process) and cuprammonium cellulose (cuprammonium process). Since the above-mentioned rayon or other regenerated cellulose is used for the material for the nonwoven sheet of the present invention, the paper differs from inserting paper produced by recycling paper and inserting paper produced by wood pulp etc. and is increased in uniformity of the contained ingredients.

When forming inserting paper for glass-like sheet materials as a woven sheet from the above-mentioned fiber-shaped rayon or cuprammonium cellulose, in general, it is necessary to suitably impregnate the rayon or cuprammonium cellulose fibers with a lubricating oil in the loom and therefore the final woven sheet has residual oil or other impurities. Therefore, in particular when envisioning utilization for the transport etc. of glass substrates for flat panel displays (FPDs), dirt on the surface of the glass substrates due to the residual oil is a concern. Further, when using a conventional woven sheet made of rayon or cuprammonium cellulose fibers as inserting paper for glass-like sheet materials, removal of the oil from the woven sheet itself becomes separately required, so the work process is complicated, and the cost rises. Accordingly, inserting paper for glass-like sheet materials is suitably made a nonwoven sheet made from cellulose.

In forming the nonwoven sheet, there is also the method of adding various known binders to the fiber-shaped cellulose. However, in view of the object of the present invention of suppressing as much as possible the dirt on of the surface of the glass-like sheet materials, a nonwoven sheet formed without using a binder should be used. As a process of production not using a binder, the needle punching process of punching fibers of prespun rayon or cuprammonium cellulose by needles to entangle them etc. may be illustrated, but

the needles have to be suitably coated with a lubricating oil. Therefore, this is not preferred for the same reasons as with utilization of a loom.

From the above viewpoint, as a process of production not using a binder, a production process like the spunlace process entangling adjoining fibers of preformed rayon, cuprammonium cellulose, etc. by high pressure jets of water is utilized so as to produce a nonwoven sheet made of regenerated cellulose. Further, for rayon, the method of continuously spinning a fiber solution (viscose) and adhering the fibers with each other by hot pressing to produce the nonwoven sheet and, for cuprammonium cellulose, the method of continuously adhesion by hydrogen bonds utilizing the surface swellability of active fibers in the unregenerated state (Blau Faden (blue fiber)) and entangling the fibers by high pressure jets of water to produce the nonwoven sheet may be illustrated.

The "hot water solubles" in the present invention are the ingredients dissolving in hot water expressed as a percent of the total weight of the nonwoven sheet. As explained in the section on the background art, at the time of transport and storage of glass-like sheet materials, moisture in the air is absorbed by the inserting paper, so dirt on the glass surface due to elution of the ingredients in the inserting paper was considered a problem. Therefore, the hot water solubles (hot water soluble ingredients) is used as an indicator for determining the elution of ingredients of the inserting paper.

The hot water solubles in the present invention, as explained in detail in the later mentioned example, is measured based on "TAPPI T207 om-81, Water Solubility of Wood and Pulp, 6.2. Hot Water Solubility" prepared by the Technical Association of the Pulp and Paper Industries (TAPPI). As described in Japanese Patent Publication (A) No. 2003-41498 disclosed in the section on the background

art, in inserting paper for glass-like sheet materials made by a method of recycling paper, it was considered extremely difficult to reduce the hot water solubles to less than 0.1 wt%. As opposed to this, the present invention, as clear from the later explained example, uses cellulose as the material and does not include almost any other impurities, so it is possible to reduce the hot water solubles to less than 0.1 wt%. This is considered effective for preventing paper marks on the surface of the glass-like sheet materials (in particular, glass substrates).

In obtaining a nonwoven sheet made from regenerated cellulose, the explanation will be given with reference to a nonwoven sheet produced by the viscose process.

Fibers (cellulose) obtained from cotton, pulp, etc. are made to react with carbon disulfide in the presence of an alkali to prepare viscose. This is spun in a spinning bath containing formaldehyde or another methylolation agent to obtain a spun fiber 10 comprised of three layers shown in the sectional view of FIG. 1, that is, cellulose 11, hydroxymethyl cellulose xanthate (hereinafter referred to as "HMCX") 12, and sodium cellulose xanthate (hereinafter referred to as "NaCX") 13.

The general chemical structures of the three components of the above spun fiber 10 are shown in Table 1.

Table 1

Component	Chemical structure
HMCX	Glucose-O-CS_2-CH_2OH | O | Glucose-O-CS_2-CH_2OH | O | Glucose-O-CS_2-CH_2OH | O
NaCX	Glucose | O | Glucose-O-CS_2-Na | O | Glucose | O
Cellulose	Glucose | O | Glucose | O | Glucose | O

The above three-layer spun fiber 10 is suitably cut, dispersed, and processed to form a substantially planar material. By hot pressing at the time of embossing using an embossing roller in the presence of moisture, the HMCX is liquified by heat and nearby spun fibers are fused together. When further heated, the HMCX breaks down and is changed to cellulose to form the fused parts 21 shown in the partially enlarged view of FIG. 2 and solidify. After this, the material is shrunken at a suitable temperature and pH in the presence of a weak acid whereby the above-mentioned HMCX and NaCX are converted to cellulose. Next, the material is bleached, rinsed, dried, etc., whereby a nonwoven sheet 20 made of

cellulose and formed without using a binder is obtained. Reference numeral 22 shows the regenerated cellulose converted to cellulose inside.

As explained above, the present invention for glass-like sheet materials of the present invention contains cellulose derivatives in its production process, but these are finally converted to cellulose, so cellulose can be said to be its material.

At the time of forming the nonwoven sheet, in particular at the time of embossing, it is preferable to further press the material by a flat roller. If using a flat roller in this way, the spun fibers fused by the embossing further are pressed by the flat roller to smooth the material and simultaneously keep down fluff of the short spun fibers. Therefore, the pressing by the flat roller acts effectively as treatment for preventing dust. Note that the shape and size of the embossing, the amount of pressing by the flat roller, etc. are suitably set.

In addition, the nonwoven sheet obtained by complete conversion of the internal ingredients of the spun fiber to cellulose and by bleaching, rinsing, drying, etc. is sometimes treated to prevent dust by suction of the fluff on the surface of the nonwoven sheet by using the suction system 30 shown in the schematic sectional view of FIG. 3 for example at the time of taking it up after drying. The suction system 30 blows air injected from a pressurizer 32 to the surface of the nonwoven sheet 20 transferred by a transfer roller 45 while causing the surface of the nonwoven sheet to vibrate through application of ultrasonic waves from an ultrasonic wave generator 33 so as to free the dust generating factors of the nonwoven sheet 20, sucks them into the suction unit 31, and exhausts them outside from the exhaust port 35. FIG. 3 shows an example of suction of dust generating factors from one side of the nonwoven sheet 20, but it is preferable to suck the dust generating factors

off from both surfaces of the nonwoven sheet. Reference numeral 34 is a suction port, while 40 is a static electricity eliminator.

In general, as the mode of use of inserting paper used for glass-like sheet materials, as disclosed in Japanese Patent Publication (A) No. 49-13865, at least one of the inserting paper and glass-like sheet material is charged with a predetermined voltage and the static electricity generated at that time is used to make the two stick together. That is, static electricity is used to cause the inserting paper and glass-like sheet material to stick together so as to facilitate the work of inserting the inserting paper in the glass-like sheet materials.

However, the surface of the nonwoven sheet is rougher in surface shape compared even with the conventional inserting paper. Therefore, the contact area between the glass-like sheet material and the nonwoven sheet is smaller than that of the conventional inserting paper and it cannot be said that a sufficient effect of improvement of adhesion is obtained by the electrostatic charging. Accordingly, it can be said to be preferable to improve the smoothness of the nonwoven sheet as much as possible to improve the adhesion of the nonwoven sheet and glass-like sheet materials when charging them with static electricity.

Therefore, to improve the smoothness of the surface of a nonwoven sheet formed as explained above and treated to prevent dust, supercalendering is performed. The above supercalendering is usually performed by passing the nonwoven sheet of the present invention through multiple stages of a total of 5 to 20 stages of alternate metal rolls and nonmetal elastic rolls and pressing it by a linear pressure of 1900 to 2600 N/cm (maximum of about 3500 N/cm). Due to the supercalendering, the nonwoven sheet is subjected to a high pressure and becomes thinner. At the same time, the generation of dust from the surface of the nonwoven sheet

is reduced and the smoothness is increased as well. Note that the pressure (linear pressure), temperature, moisture content of the nonwoven sheet, pressing time, and other treatment conditions in the supercalendering are suitably set.

Here, the smoothness of the nonwoven sheet of the present invention is defined as the surface smoothness of the nonwoven sheet (inserting paper for glass-like sheet materials). The surface roughness is quantized in measurement by a KES-FB-4S surface tester made by KES Co. and is suitably not more than 1.5 μm, preferably not more than 1.2 μm. As will be clear from the later explained example, the more a sample is supercalendered to improve its smoothness, the better the results obtained in electrostatic adhesion. Considering the above, a link between the surface roughness and electrostatic adhesion is deduced and the suppression of surface roughness is used an indicator of improvement of the electrostatic adhesion.

Note that while inserting paper for glass-like sheet materials was explained in detail above in the present invention, when producing the inserting paper, the embossing using the embossing roller may be omitted in fusing the spun fibers and only pressing by the flat roller may be performed. Further, when producing the inserting paper comprised of the nonwoven sheet, the pressing by the flat roller and the supercalendering are suitably incorporated into the process considering the production facilities, production costs, etc. They are not limited to the above process.

EXAMPLE

The inventors, as explained above, used a nonwoven sheet formed from cellulose without using a binder as the inserting paper for glass-like sheet materials of the present invention. They prepared a nonwoven sheet produced by the viscose process as explained in detail above (made by Futamura Kagaku

Kogyo K.K., Taiko TCF) as the inserting paper for glass-like sheet materials of the example of the invention. The nonwoven sheet of the example was pressed by a flat roller at the time of embossing as treatment for dust prevention.

Further, they made a comparative evaluation of the inserting paper of the example of the invention using as comparative examples inserting paper actually used as the inserting paper for glass sheets for flat panel display substrates. For the inserting paper of the comparative examples, they used inserting paper comprised of acidic paper made by pulp by the usual method (made by N company, NDP) as Comparative Example 1, inserting paper comprised of neutral paper (made by N company, NDP), as Comparative Example 2, and inserting paper made from recycled paper (made by T company, ATP) as Comparative Example 3.

Measurement of Hot Water Solubility

The inserting paper of the example of the invention and Comparative Examples 1 to 3 were evaluated based on the above "TAPPI T207 om-81, Water Solubility of Wood and Pulp, 6.2. Hot Water Solubility". Specifically, a 5 g sample was taken from the inserting paper of each of the example of the invention and Comparative Examples 1 to 3, 250 g of distilled water was added, and the mixture was continuously boiled for 30 minutes. The extract was filtered, 250 g of distilled water was again added, and boiling continued for 30 minutes. This operation was repeated three times and the extracts of the three times were combined.

The combined extract was concentrated and dried in an evaporation dish, then weighed. The ratio by weight of the dried solid to the sample was found as the hot water solubles (wt%). The results are shown in Table 2.

Table 2

Sample	Material of inserting paper	Hot water solubles (wt%)

Example	Cellulose nonwoven sheet	0.08
Comp. Ex. 1	Acidic paper	0.42
Comp. Ex. 2	Neutral paper	0.44
Comp. Ex. 3	Recycled paper	0.91

As will be understood from the results of Table 2, the inserting paper for glass-like sheet materials of the example of the invention does not use a binder at the time of forming the pulp into paper as compared with the inserting papers of Comparative Examples 1 to 3, so the content of hot water solubles is clearly lower. It can be deduced that this is effective for preventing paper marks on the glass surface.

Evaluation of Effect on Glass Surface

The inserting papers of the example of the invention and Comparative Examples 1 to 3 were cut to strips, arranged in parallel, and clamped between two pieces of sheet glass for a TFT-LCD module. Further, the glass was sandwiched between styrofoam so that a uniform pressure could be given and the assembly secured by rubber bands. The assembly of the sheet glass and inserting papers was exposed for a maximum of 318 hours to a temperature of 60°C and relative humidity of 95%.

Steam was applied to the sheet glass surface of the assembly of the sheet glass and inserting paper until fogging it, then a fine porous urethane sponge was used to strongly rub off once the inserting papers so that a uniform pressure is applied to the adhered surface. The surface of the sheet glass was dried, then steam was again applied and the degree of peeling of the paper marks on the surface where the inserting paper was adhered was evaluated in four stages visually. In this evaluation, inserting paper leaving paper marks wiped off the best from the adhered surface was evaluated as "1", while inserting paper leaving paper marks

wiped off the worst from the adhered surface was evaluated as "4". The evaluation values were totaled for each elapsed time and an overall evaluation of four stages made. To correctly evaluate the paper marks, it was confirmed that there was no surface deterioration at the exposed portions of the sheet glass where no inserting paper was adhered. Table 3 shows the elapse of exposure time and the dirt on the surface of the sheet glass.

Table 3

Elapsed time (hr)	Example (cellulose nonwoven sheet)	Comp. Ex. 1 (acidic paper)	Comp. Ex. 2 (neutral paper)	Comp. Ex. 3 (recycled paper)
118	1	3	2	4
145	1	3	2	4
178	1.5	1.5	3	4
226	1	2	3	4
298	1	2	3	4
318	1	2.5	2.5	4
Total	6.5	14	15.5	24
Overall evaluation	1	2	3	4

As will be understood from Table 3, the inserting paper of the example of the invention can be said to exhibit good properties and stable quality compared with the inserting paper of any of the comparative examples.

Based on these results, it is suggested that a clear relationship stands between the content of the hot water solubles and dirt on the surface of the sheet glass, in particular, that the inserting paper of the example of the present invention, that is, a nonwoven sheet formed using cellulose without using a binder, is suitable as inserting paper for glass-like sheet materials at the time of transport

or storage of glass substrates where a high degree of cleanliness is required.

Preparation of Nonwoven Sheet

Convinced of the suitability of nonwoven sheet from the above findings, the inventors produced three types of nonwoven sheet differing in basis weight (g/m^2) and surface roughness (μm) (made by Futamura Kagaku Kogyo K.K., Taiko TCF Series) obtained by the viscose process as explained in detail above. The three types of nonwoven sheet are identified as the Sample 1-1, Sample 1-2, and Sample 1-3 in the following. Note that only the nonwoven sheet of Sample 1-3 was pressed by a flat roller at the time of embossing.

Further, the inventors supercalendered the nonwoven sheets of Sample 1-1, Sample 1-2, and Sample 1-3 to control the smoothness of the surfaces of the nonwoven sheets. In the following, the nonwoven sheet obtained by supercalendering Sample 1-1 is identified as Sample 2-1, the nonwoven sheet obtained by supercalendering Sample 1-2 is identified as Sample 2-2, and the nonwoven sheet obtained by supercalendering Sample 1-3 is identified as Sample 2-3. The conditions of the supercalendering were 14 stages, 13 nips, a linear pressure of 1960 N/cm, a temperature of 80°C, and a processing speed of 60 m/min.

Measurement of Surface Roughness

The surface roughnesses of the nonwoven sheets of the samples were measured using a KES-FB-4S surface tester made by KES Co. The measurement conditions were a stationary load of 98 mN, a tension of 196 mN/cm, a probe contact length of 5 mm, a tensile speed of 0.1 cm/sec, and a tensile distance of 2 cm. At the time of measurement of the samples, measurement was conducted five times each vertically and horizontally. The average value vertically and the average value horizontally were calculated and the larger value was

used as the surface roughness of each sample.

Measurement of Electrostatic Adhesion

In a room held at a temperature of 20°C and a relative humidity of 65%, nonwoven sheets of the samples cut to the A4 size (about 210 mm x 297 mm) were placed on TFT-LCD module sheet glass cut to the same A4 size. From above these nonwoven sheets, an electrostatic charging system (Electrostatic Eliminator JPK-3 made by Kasuga Denki Inc.) was used to give -20 kV of static electricity for charging. In this case, the charging electrode opening of the electrostatic charging system was held at a position 5 cm right above the nonwoven sheets of the samples while charging the nonwoven sheets as a whole.

The sufficiently charged assembly of the sheet glass and nonwoven sheets of the samples was turned completely upside down and the times until the nonwoven sheets of the samples completely peeled off and dropped from the sheet glass were calculated. However, the time was only measured until 20 seconds.

The physical properties and measurement results of the nonwoven sheets of Sample 1-1, Sample 1-2, Sample 1-3, Sample 2-1, Sample 2-2, and Sample 2-3 and the afore-mentioned Comparative Example 2 (neutral paper) are shown in Table 4.

Table 4

	Untreated			Supercalendered			Comp. Ex. 2 (neutral paper)
	Sample 1-1	Sample 1-2	Sample 1-3	Sample 2-1	Sample 2-2	Sample 2-3	
Basis weight (g/m^2)	80	40	40	80	40	40	35
Density (g/m^3)	0.18	0.16	0.21	0.77	0.63	0.81	0.55
Surface roughness (μm)	6.0	3.5	1.8	1.2	1.2	0.8	1.5

Electrostatic adhesion (seconds until peeling)	5 sec	10 sec	13 sec	20 sec or more	20 sec or more	20 sec or more	20 sec or more

As will be understood from Table 4, compared with the Sample 1-1, Sample 1-2, and Sample 1-3, the supercalendered Sample 2-1, Sample 2-2, and Sample 2-3 all have values of their surface roughness reduced. Along with this, it is learned that the electrostatic adhesion of the samples (duration of adhered state) was also greatly improved. Therefore, the smoothness of the surface of the nonwoven sheet can be said to be effective when improving the electrostatic adhesion. Further, by a comparison of Sample 2-1, Sample 2-2, and Sample 2-3 with Comparative Example 2, an electrostatic adhesion equal to that of conventional inserting paper (Comparative Example 2, neutral paper) was exhibited. Therefore, the inventors proved that if using supercalendered nonwoven sheet, adhesion with glass-like sheet materials utilizing static electricity becomes possible and the convenience of the work of inserting the inserting paper in the glass-like sheet materials is improved.

Measurement of Generation of Dust

In a class 10000 clean room, a polyvinyl chloride simple hood of dimensions of a vertical 700 mm, horizontal 500 mm, and depth 500 mm was assembled openable at only one side. A hole was formed at the center of the ceiling of this simple hood. The suction port of an air particle counter (The Portable, made by HIAC/ROICO) was set suspended about 10 cm inside the simple hood.

Nonwoven sheets of the Sample 1-1, Sample 1-2, Sample 1-3, Sample 2-1, Sample 2-2, and Sample 2-3 cut in advance to A4 sizes (about 210 mm x 297 mm) were folded from their

original dimensions to 1/8 size. Next, the above simple hood was opened about 100 mm and the folded nonwoven sheets of the samples were cut a total of eight times each using cutting scissors at a speed of 5 seconds per time at about the center of the simple hood.

Among the particles flying off from the samples into the clean room due to the above cutting, in particular the particles of at least 0.3 μm size were measured by the above-mentioned air particle counter. The results of the count are shown in Table 5. Note that the count of the particles was found as the number of particles per unit cubic foot. For reference, values converted to unit cubic meter are also given.

Table 5

	Untreated			Supercalendered		
	Sample 1-1	Sample 1-2	Sample 1-3	Sample 2-1	Sample 2-2	Sample 2-3
No. of particles of 0.3 μm or more (particles/ft^3)	8,095	3,035	675	2,890	1,555	295
Converted value (particles /m^3)	285,840	107,168	23,835	102,048	54,908	10,417

As will be understood from Table 5, compared with Sample 1-1, Sample 1-2, and Sample 1-3, the supercalendered Sample 2-1, Sample 2-2, and Sample 2-3 all had particle counts reduced to about half. Therefore, it is learned that supercalendering is effective as treatment for prevention of generation of dust from nonwoven sheet.

As a result, the application of inserting paper which had been limited to use for the "glass sheet" to be later coated with thin film to form a glass substrate in the past can be expanded to the transport or storage of the "glass substrate" supplied to display manufacturers. Therefore, even during transport or storage or glass substrates etc.,

the amount of transport and amount of storage per time can be improved without relying on packaging spacers.

While the invention has been described with reference to a specific embodiment chosen for purpose of illustration, it should be apparent that numerous modifications could be made thereto by those skilled in the art without departing from the basic concept and scope of the invention.